

## **MEMBRANE WATERPROOFING (DECK SEAL)**

**March 8, 1993**

### **Description**

This work consists of furnishing and placing an approved waterproofing membrane over a properly prepared concrete bridge deck prior to placing the asphalt concrete overlay, in accordance with these specifications, and in reasonably close conformity with the Plans or as directed by the Engineer.

The waterproofing membrane for this project shall be selected by the Contractor from one of the following systems:

#### **System A**

A factory laminated sheet composed of either suitably plasticized coal tar or rubberized asphalt reinforced with a polypropylene fabric and primed in accordance with the manufacturer's recommendations.

#### **System B**

A hot-applied, rubberized elastomeric membrane with primer if required by the manufacturer.

#### **System C**

A hot-applied reclaimed rubber/asphalt membrane.

### **Preparation of Concrete Deck**

The entire deck and the sides of the curb to the height of the asphalt overlay shall be essentially free of all foreign material such as dirt, grease, etc. Prior to applying the primer or liquid membrane, all dust and loose material shall be removed from the deck with compressed air. Any surface defects such as spalled areas, cracks, protrusions, etc., that will decrease the effectiveness of the membrane by puncturing, stretching, etc., shall be corrected prior to application of the membrane.

### **Weather and Moisture Limitations**

Work shall not be done during wet weather conditions, nor when the deck and ambient air temperatures are below 50 degrees F. The deck shall be surface-dry at the time of the application of the primer or liquid membrane.

The Engineer may order work to be suspended in accordance with Section 1-08.6 because of the above weather and moisture limitations.

### **New Concrete Areas**

All areas of the deck that have less than 28 day old concrete shall be allowed to cure for a period of time recommended by the membrane manufacturer or as ordered by the Engineer before application of the membrane.

### **Concrete Protection**

The Contractor shall use care to protect all concrete surfaces from damage. Any damage to exposed surfaces shall be repaired at the Contractor's expense.

### **Membrane Application**

The primer and membrane waterproofing shall extend from the roadway deck up onto the curb face the thickness of the asphalt overlay. Special care shall be used at the curb face to see that the membrane adheres to the concrete.

The Contractor shall not begin application of membrane waterproofing deck seal to the bridge until he has demonstrated, to the satisfaction of the Engineer, that all labor, equipment, and materials necessary to apply the membrane and asphalt concrete

1 overlay are either on hand or readily available to complete the work in a timely  
2 manner.

### 3 4 **Membrane Protection**

5 The membrane material shall be protected from damage due to the paving operations.  
6 The method of membrane protection for Membrane Systems A and B shall be as  
7 recommended by the manufacturer of the membrane system and approved by the  
8 Engineer. The method of membrane protection for Membrane System C shall be as  
9 specified under Membrane System C.

10  
11 No traffic or equipment except that required for the actual waterproofing and paving  
12 operations will be permitted to travel or rest on the membrane waterproofing until it is  
13 covered by the asphalt overlay.

### 14 15 **Asphalt Concrete Overlay**

16 The membrane manufacturer's recommendations shall be thoroughly considered in the  
17 application of the asphalt concrete overlay particularly as to the type of paving  
18 machine, laydown temperature of the asphalt concrete, protection of membrane while  
19 paving, rolling temperature and technique, and other items unique to each membrane.  
20 Differences in application procedure shall be resolved by the Engineer and his  
21 decision shall be final. Vibratory rollers shall not be used on bridge decks.

### 22 23 **Evaluating Waterproofing Effectiveness**

24 When, in the Engineer's judgment, it is indicated that the completed sections of the  
25 waterproofing membrane should be evaluated for waterproofing effectiveness prior to  
26 application of membrane protection, evaluation of the waterproofing membranes  
27 effectiveness will be performed in the following manner:

- 28  
29 a) For decks with epoxy-coated reinforcing bars, the waterproofing membrane  
30 will be visually inspected for uniformity of application, tears, punctures, and  
31 bonding. All such deficiencies shall be repaired as approved by the Engineer  
32 prior to placement of the membrane protection.  
33  
34 b) For decks with uncoated reinforcing bars, testing by WSDOT Test Method  
35 No. 413A will be performed. Any portion of the membrane found to have a  
36 resistance reading below 100,000 ohms shall be repaired. Those  
37 membranes which provide less than 70 percent readings above 250,000  
38 ohms shall be replaced or, at the option of the Contractor, repairs may be  
39 made to bring the membrane to the acceptance level. After completion of the  
40 asphalt overlay, a final evaluation of the waterproofing effectiveness of the  
41 membrane/pavement system will be made in accordance with WSDOT Test  
42 Method No. 413A. The acceptance standards for the pavement/membrane  
43 system shall be 70 percent readings above 250,000 ohms and no single  
44 reading below 100,000 ohms. Those areas requiring repair or replacement to  
45 meet acceptance standards shall be repaired or replaced as approved by the  
46 Engineer.

47  
48 The testing will be conducted by state forces.

49  
50 The Engineer will not require testing of the waterproofing membrane to evaluate the  
51 waterproofing effectiveness for precast prestressed member bridges, (i.e. precast  
52 prestressed concrete bridges without cast-in-place concrete roadway decks).

## **Membrane System A**

### **Materials**

#### **Primer**

The primer used to bond membrane to deck and to seal seams and patches shall be a water resistant adhesive compatible with the membrane. The primer shall be of suitable consistency for application by brush, roller, or spray without further dilution.

#### **Membrane**

The membrane shall be factory-laminated sheet composed of either suitably plasticized coal tar or rubberized asphalt reinforced with polypropylene fabric. It shall be manufactured free from blemishes, discontinuities, and other defects. The membrane shall be supplied in rolls, having a minimum width of 36 inches, and shall conform to the following requirements:

Thickness:	65 mils minimum
Pliability (1):	No cracks

- (1) Place a 4 inch by 1 inch membrane specimen in a -10 degree F cold chamber for two hours. While still in the cold chamber, bend the specimen 180 degrees over a 1 inch radius mandrel. Remove specimen from cold chamber and inspect for cracks.

### **Application**

The primer shall be applied to the cleaned concrete surfaces at the rate and according to the procedure recommended by the membrane manufacturer. All surfaces to be covered by the membrane shall be thoroughly and uniformly coated with primer. Precautionary measures shall be taken to ensure that pools and thick layers of primer are not left on the deck surface to scum over. Drying time prior to applying the membrane shall normally be as recommended by the manufacturer, however, the membrane shall not be applied until substantially all volatile material has dissipated from the primer.

The prefabricated membrane shall be applied to the primed curb and bridge deck surfaces by either hand methods or mechanical applicators. The membrane shall be placed in such manner that a shingling effect will be achieved and that any water which accumulates will drain toward the curb and the drain pipes. Each strip shall be overlapped a minimum of 4 inches or as recommended by the manufacturer. An adhesive or a wide tipped torch to cause tackiness shall be used, if necessary, to assure a good seal of the joints. Hand rollers or other satisfactory pressure apparatus shall be used on the applied membrane to assure firm and uniform contact with the primed concrete surfaces.

Any torn or cut areas, or narrow overlaps, shall be patched using a satisfactory adhesive and by placing sections of the membrane over the defective area in such a manner that the patch extends at least 6 inches beyond the defect. The patch shall be rolled or firmly pressed onto the surface.

The fabric shall be neatly cut and contoured at all joints as directed by the Engineer.

After the membrane waterproofing has been completed, the membrane shall be cut with two right angle cuts at all deck drain pipes. The cuts shall be made to the inside diameter of the drain pipes, after which the corners of the membrane waterproofing shall be turned down into the drains and laid in a coating of asphalt binder.

## Membrane System B

### Materials

#### Primer

The primer, if required, shall meet the manufacturer's recommendations.

#### Membrane

The membrane shall meet the following requirements:

Viscosity, SSF at 350 degrees F	ASTM E 102	950-1350
Softening Point, degrees F	ASTM D 2398	165 Min.
Adhesion, psi	ASTM D 429(1)	15 Min.
Cold Bend Test, Minus 10 degrees F		(2) No cracks
Compatibility with Asphalt		Complete

- (1) Adhesion ASTM D 429, Method A(Modified). This is a tension test of vulcanized rubber to steel. Coat the surfaces of the 2 metal plates described in the procedure with an epoxy resin of at least 2000 psi tensile strength. Stand the coated ends on Ottawa sand (ASTM C 109). Apply a pressure of 10 lbs. for a minimum of eight hours to ensure adequate bedding of the sand in the resin. Brush all loose particles from the treated metal surface and coat each with 0.3 gram of primer.

Cover the bottom of a cylindrical thin film oven test pan (ASTM D 1754) with a release paper such as Technipeel No. 985 made by the Brown Paper Company of Kalamazoo, Michigan. Any release paper that retains its release properties after use is satisfactory.

Pour 50 grams of membrane (350 - 375 degrees F) into the release-treated pan. Allow the membrane to cool to ambient temperature. Remove it from the pan and cut circular sections to fit the metal plates or discs coated as above.

Fit the circular section of membrane on one metal disc and place the other metal disc over it. Put this sandwich in a 140 degree F oven. Place a one kg weight on it and leave in the oven for two hours.

Test in accordance with ASTM D 429, Method A, and calculate adhesion as total load at failure divided by area of adhered surface, whether failure occurred at bonded surface or within the membrane material.

- (2) Cold Bend Test. Pour 50 grams of membrane into a container, as described for the adhesion test. Allow it to cool to ambient temperature and remove from the pan.

Dust both sides lightly with talc to prevent stickiness.

Place the specimen in a -10 degree F cold chamber for two hours. While still in the cold chamber, bend the specimen 180 degrees over a radius not to exceed 1 inch.

Remove the membrane from the cold chamber and check for cracks. Only material which shows no cracks will be considered satisfactory.

## **Application**

### **Primer**

The primer, if required, shall be applied to the pavement as specified by membrane manufacturer.

### **Membrane Application**

If the primer has become contaminated, the pavement shall be cleaned and a new primer applied and allowed to cure before the membrane is applied.

The membrane material shall be heated in accordance with the manufacturer's recommendations. To ensure against overheating, a double-boiler type heater shall be used and the membrane material shall be circulated or agitated during the heating process.

The membrane shall be applied to the clean, dry (primed) surface at a nominal rate of 0.5 gallon per square yard and in accordance with the manufacturer's recommendations as to application temperatures.

Placement of the asphalt concrete wearing surface shall be done in accordance with the recommendations of the coating manufacturer.

## **Membrane System C**

Membrane System C shall consist of an asphalt/rubber membrane together with a membrane protective fabric. The asphalt/rubber membrane shall be produced by one of the two known proprietary processes combining granulated tire rubber with asphalt cement. Method 1 uses a ground, vulcanized rubber and an extender oil where as Method 2 uses ground vulcanized rubber and a kerosene diluent. Either method is acceptable based on proper compliance with the specification and certification of materials.

## **Materials**

### **Asphalt Cement**

The asphalt shall be paving grade asphalt meeting the requirements for AR-1000 as specified in the uniform Pacific Coast Asphalt Specifications or it shall be AR-2000W or AR4000W conforming to Section 9-02.1(4).

### **Rubber Extender Oil (Method 1)**

The extender oil shall be a resinous, aromatic hydrocarbon meeting the following requirements when tested as indicated:

Test	ASTM Test Method	Requirement
Viscosity, SSU at 100°F	D 88	2,500 min.
Flash Point, COC Open Cup	D 92	392 min.
Molecular Analysis:	D 2007	
Asphaltenes, percent by Weight		0.1 max.
Aromatics, percent by Weight		55.0 min.

### **Kerosene Type Diluent (Method 2)**

The kerosene type diluent used shall be compatible with all materials used and shall have a flash point (ASTM D 92) of not less than 80°F. The initial boiling point shall be not less than 300°F with a total distillation (dry point)

before 450°F (ASTM D 850). The Contractor is cautioned that a normal kerosene or range oil cut may not be suitable.

## Ground Rubber Components

### Method 1

The rubber shall meet the following physical and chemical requirements:

The granulated crumb rubber shall contain  $22 \pm 5$  percent by weight natural rubber and shall meet the following requirements:

<u>Sieve Size</u>	<u>Percent Passing</u>
U.S. No. 8	100
U.S. No. 30	40-75
U.S. No. 50	10-35
U.S. No. 100	0-15

The sieves shall comply with AASHTO M 92 (ASTM E 11). All percentages are by weight.

The specific gravity of the rubber shall be  $1.15 \pm 0.05$  and shall be free of fabric, wire, or other contaminating materials, except that up to four percent of calcium carbonate may be included in the rubber to prevent particles from sticking together.

### Method 2

The combined granulated rubber shall consist of a minimum of 80 percent by weight of vulcanized rubber produced by the processing of tires. The rubber shall consist of one type or a blend of types as indicated below. The type or blend selected shall be based on laboratory testing by the asphalt/rubber supplier.

The granulated rubber types shall meet the following gradation:

<u>Sieve Sizes</u>		<u>Percent Passing</u>		
		Type 1	Type 2	Type 3
U.S. No. 8	(2.36mm)	100	---	---
U.S. No. 10	(2.00mm)	95-100	---	---
U.S. No. 16	(1.18mm)	---	100	100
U.S. No. 30	(0.600mm)	0-10	60-90	95-100
U.S. No. 50	(0.300mm)	0-5	0-20	30-60
U.S. No. 80	(0.180mm)	---	0-5	15-35
U.S. No. 200	(0.075mm)	---	---	0-10

The sieves shall comply with the requirements of AASHTO M 92 (ASTM E 11). All percentages are by weight.

The individual granulated rubber particles, regardless of diameter, shall not be greater in length than 0.250 inch for Type 1 or 0.125 inch for Type 2 and Type 3.

The combined granulated rubber shall have a specific gravity of  $1.15 \pm 0.05$  and shall be free of loose fabric, wire and other contaminants except that up to four percent (by weight of rubber) calcium carbonate or talc may be added to prevent rubber particles from sticking together.

The rubber shall be sufficiently dry to be free flowing and not produce foaming when blended with the hot asphalt cement.

### **Fabric For Membrane Protection**

The fabric shall be a polypropylene material having the following properties:

Tensile strength, either direction, min. 47 lbs. (WSDOT Test Method 916)

Weight, oz./sq. yd.	3-6
Width, inches	36 min.

### **Certification of Quality Assurance**

The asphalt/rubber supplier shall furnish the Engineer the asphalt/rubber mix formulation which shall contain the following information, a minimum of seven days prior to starting placement of the membrane:

Asphalt Cement	Granulated Rubber
Grade of asphalt	Total rubber content, weight
Source of asphalt	Percent of asphalt/rubber mixture
Rubber type(s) and content of each type (if blend), weight, and percent of combined rubber:	

#### Asphalt Modifier

Type of Modifier
Quantity of modifier, weight
Percent of asphalt cement

The Contractor shall submit certifications that the asphalt cement is compatible with the rubber. New certifications will be required if the asphalt cement is changed. The supplier shall furnish a certificate of compliance with these specifications for each shipment.

The granulated rubber shall be accepted by certification from the rubber supplier.

### **Preparation of Asphalt/Rubber**

#### **Both Methods**

The method and equipment for combining the rubber and asphalt shall be so designed and accessible that the Engineer can readily determine the percentages, by weight, of each of the two materials being incorporated into the mixture.

#### **Method 1**

The rubber and modified asphalt shall be combined in a ratio of  $20 \pm 2$  percent rubber to  $80 \pm 2$  percent asphalt by weight and reacted for a sufficient time at  $400^{\circ} \text{F} \pm 25^{\circ} \text{F}$  to produce a product with the following properties:

Viscosity at 400	1700 cps max.
Softening Point (R & B)	120° F min.
Flex Temperature (90° Bend Test)	20° F max.

In the event a delay occurs when the product is ready to be applied, the heat will be turned off until the job resumes.

## **Method 2**

The percent of combined rubber shall be as indicated by the mixture design for specific project requirements by weight of total mixture, that is, by total weight of asphalt cement plus asphalt modified (if used) plus granulated rubber.

The temperature of the asphalt shall be between 350° and 425° F (177° to 218° C) at the addition of the vulcanized rubber. The asphalt and rubber shall be combined and mixed together in a blender unit then reacted in the distributor for a period of time as required by the Engineer and, based on laboratory testing, by the asphalt/rubber supplier. The temperature of the asphalt/rubber mixture shall be above 325° F (163° C) during the reaction period.

After the reaction between asphalt and rubber has occurred, the viscosity of the hot asphalt/rubber mixture may be adjusted for spraying or better wetting of the cover material by the addition of a diluent. The diluent shall comply with the requirements for kerosene type diluent (Method 2) and shall not exceed 7.5 percent by volume of the hot asphalt/rubber mixture.

When a job delay occurs after full reaction, the asphalt/rubber may be allowed to cool. The asphalt/rubber shall be reheated slowly just prior to application but not to a temperature exceeding 325° F (163° C). An additional quantity of diluent not exceeding three percent by volume of the hot asphalt/rubber mixture may be added after reheating.

## **Construction of Membrane Equipment**

The equipment used for mixing and spreading the asphalt and rubber shall be a self-powered pressure distributor equipped with a separate power unit, a distributing pump capable of pumping the specified material at the specified rate through the distributor tips, and equipment for heating the bituminous material. The distribution bar on the distributor shall be fully circulating with nipples and valves so constructed that they are bathed in the circulating asphalt to the extent that the nipples will not become partially plugged with congealing asphalt. Distributor equipment shall include a tachometer, pressure gauges, volume measuring devices, and a thermometer for reading temperatures of tank contents. The spray bars on the distributor shall be controlled by a bootman riding at the rear of the distributor in such a position that operation of all sprays is in full view and accessible to him for controlling spread widths.

## **Application**

The application rate of the hot asphalt/rubber mixture shall be  $0.55 \pm 0.10$  gallon per square yard uniformly applied.

All transverse joints shall be made by placing building paper over the ends of the previous applications, and the joining application shall start on the building paper used. Once the application process has progressed beyond the paper used, the paper shall be removed and disposed of to the satisfaction of the Engineer. If the Contractor can demonstrate the ability to produce satisfactory transverse joints without paper, no paper will be required as long as the joints remain



1 satisfactory. Any unsatisfactory joint shall be repaired at the  
2 Contractor's expense.

### 3 4 **Membrane Protection**

5 Prior to overlaying with asphalt concrete, the asphalt/rubber mixture  
6 shall be covered with membrane protection fabric. The fabric shall  
7 be aligned and carefully rolled or broomed into the asphalt/rubber  
8 mixture. Rolling or brooming the fabric into the asphalt should be  
9 accomplished in such a way that any air bubbles which form under  
10 the fabric will be removed. This can best be accomplished by  
11 brooming from the center of the fabric toward the outer edges.  
12 Initial alignment is very important since the fabric direction cannot  
13 be changed appreciably without causing wrinkles. If the alignment  
14 of the fabric must be changed, the fabric shall be cut and realigned  
15 overlapping the previous material and proceeding as before. All  
16 joints shall be overlapped a minimum of 1 inch.

17  
18 After the membrane waterproofing has been completed, the fabric  
19 shall be cut around the top inside of the frame of inlets and laid in a  
20 coating of asphalt binder.

### 21 22 **Measurement**

23 Membrane waterproofing will be measured by the square yard. The area to be  
24 measured will be the area of the bridge deck and curb which is satisfactorily sealed  
25 and accepted.

### 26 27 **Payment**

28 The unit contract price per square yard for "Membrane Waterproofing (Deck Seal)"  
29 shall be full pay for performing the work as specified. The price paid shall include  
30 repairing any damaged or defective waterproofing membrane and damaged asphalt  
31 overlay.